

## NASA Earth Science in Action

From the vantage point of space, NASA works to increase our understanding of our planet, improve lives, and safeguard our future. America's space agency develops and shares tools, observations, and applications to help map and measure our planet's vital signs and study natural and human-caused changes to our climate and environment.

NASA operates dozens of missions to help us understand Earth on a global scale, while also connecting local events and phenomena to the big picture. Using satellites, airplanes, balloons, ships, ground stations, and the International Space Station, scientists collect data about our air and clouds; about forests, desert, cities; about ocean currents, temperatures, and life; and ice on land and in the sea.

These datasets are free and available to people all over the world. NASA is committed to making science accessible, collaborative, and inclusive for everyone from the scientist and student to the city manager and citizen — an approach known as "open science."

You can access some of that data — and help contribute to it — through GLOBE, a citizen-science program supported by NASA. Download the GLOBE app, and start collecting photos and data on clouds, dust storms, water bodies, and other features of our planet.

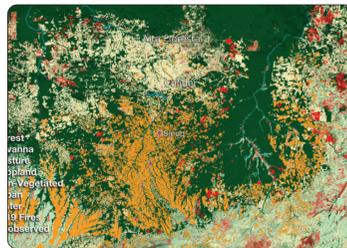
Download this poster at: [landsat.gsfc.nasa.gov/ESW2023](https://landsat.gsfc.nasa.gov/ESW2023)



### C. Satellites on Toxic Algae Patrol

Algae and phytoplankton are a diverse group of floating, plant-like organisms that capture sunlight and nutrients and turn them into energy. They are the grass of the sea, forming the center of the ocean food web.

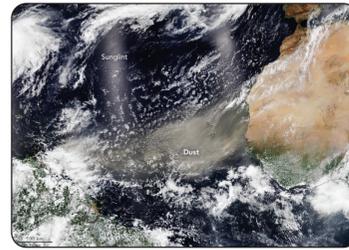
When conditions are right, algae can sometimes multiply into incredible blooms that are visible from space. While not all blooms are harmful, a growing number of them produce toxins dangerous to humans, wildlife, and other species. Scientists are increasingly turning to satellites like Landsat to keep an eye on ocean blooms and help coastal and lakeside residents plan for and cope with them.



### D. Brazilian Land Use Over Time

Deforestation of Amazon rainforests has occurred at alarming rates over the past 30 years because of cattle ranching, farm expansion, logging, and mining. The cutting of trees in the region has serious impacts on

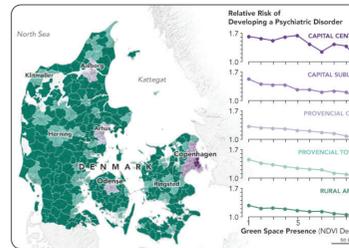
other plant and animal species, as well as water quality, soil stability, indigenous populations, and regional and global climate. NASA-funded scientists have collaborated with Brazilian scientists and international groups to map land cover and assess changes across the country. Such information can help researchers better understand the effects on climate, while also aiding conservation and sustainable management.



### G. Connecting Dust and Hurricanes

Dust is the one of the most abundant and common aerosol particles floating in Earth's atmosphere, and it has a significant effect on climate. Research has shown, for instance, that Saharan dust may influence the formation of

hurricanes in the North Atlantic by promoting stronger updrafts (rising air). Other times, the warm dusty plumes can dry out the air and cut off the moisture that storms need to grow. Scientists use satellite data from NASA to study how dust storms interact with hurricanes, which could ultimately lead to more accurate storm intensity forecasts that save money and lives in coastal communities.



### H. Green Space is Good for Mental Health

Studies have shown that parks and green spaces have a positive effect on our mental and physical well-being because they promote physical activity, decrease stress levels, provide connections to nature, and enable

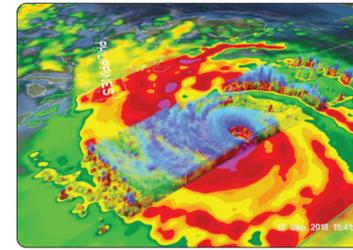
community engagement and social interaction. In a nationwide study from Denmark, researchers revealed that access to green space during childhood reduced the risk of psychiatric disorders during adolescence and adulthood. Scientists can use satellites like Landsat to map that green space and compare it with information on populations, economics, and health.



### K. Cyclone Freddy Hits Madagascar

What's the longest-lasting tropical cyclone on record? Meet Cyclone Freddy, which in February 2023 made three different landfalls in Africa while meandering for 36

days across the Indian Ocean. The storm affected the lives of millions of people, especially in Madagascar and Mozambique, through flooding and a cholera outbreak. This image of Freddy was captured on February 21, 2023, by the Suomi-NPP satellite. Satellite images and other weather data are used for forecasting and public warnings about storms, while also helping scientists learn more about what to expect from future storms.



### M. Super Typhoon Mangkhut Near the Philippines

NASA's GPM mission helps scientists understand and monitor typhoons, hurricanes, and cyclones around the world. In this image, the red and yellow colors indicate

the heavy rain that fell as Super Typhoon Mangkhut made landfall in the Philippines in September 2018. By measuring the precipitation as it is falling, scientists can better understand how storms are changing and help improve future forecasts. In remote areas with fewer weather stations, satellite data can also help emergency managers figure out where to send aid for recovery.



### L. Sprawling Shanghai

With more than 29 million residents, Shanghai is one of the most populous cities in the world and a leading center of economic and commercial activity in China. In 1984, Shanghai was a relatively compact industrial city, centered on

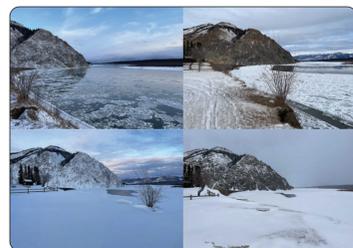
the west bank of the Huangpu River, with an estimated 7 million residents. Since then, the urban core of has expanded in all directions — across farmland and forests — and nearby villages grew into booming cities. Satellite imagery can help national and local leaders make more informed decisions about how and where we live and how we manage resources.



### N. Australian Fires Fueled Unprecedented Blooms

Wildfires can be devastating to forests, to wildlife, and occasionally to human life. But in 2019-2020, a wildfire of unusual intensity, size, and duration in eastern Australia

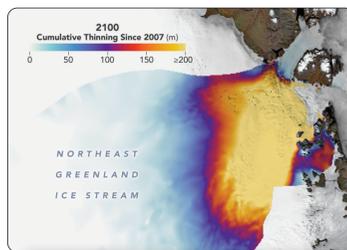
provoked a bloom of life downwind in the ocean. Smoke plumes from those wildfires lofted carbon-rich aerosols high into the atmosphere, where they blew downwind and fertilized huge phytoplankton blooms in the far South Pacific, thousands of miles away.



### A. Icy Citizen Science in Alaska

Through the Fresh Eyes on Ice program, citizen scientists help monitor ice conditions on Alaskan lakes and rivers. The work by local people, together with government and university scientists, can improve our understanding

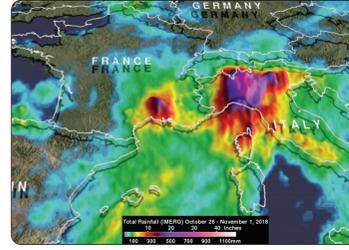
of freshwater ice ecosystems, river ice safety, and flood forecasting. It also aids long-term research on changing ice conditions. These photos show varying amounts of ice along the Yukon River near Eagle, Alaska, across autumn, winter, and early spring. You can help observe river and lake ice or other land cover, too, through the free GLOBE Observer app.



### E. Thinning of Northeast Greenland Ice

NASA and the European Space Agency have satellites that can measure the height, mass, and extent of ice around the Arctic Ocean, Greenland, and Antarctica. Using the ICESat-2 and CryoSat-2 satellites, plus NASA's

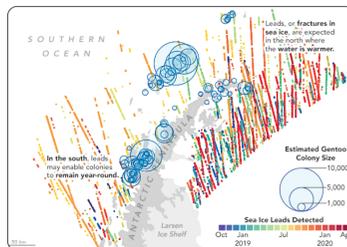
IceBridge airplane-mounted instruments, scientists measured the thinning and faster movement of the Northeast Greenland Ice Stream. Scientists use such data to project how melting ice will contribute to sea level rise, which can help coastal managers make better decisions about future development.



### I. Satellites See the Rain that Leads to Floods

NASA's Global Precipitation Measurement Mission and other satellites captured data for this estimate of rainfall accumulation in southern Europe for a week in autumn 2018. Using a tool called IMERG,

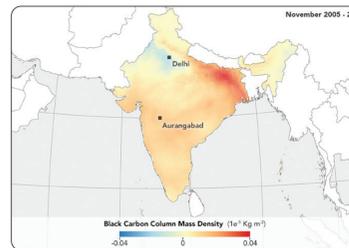
scientists found that the most extreme rainfall in southern Europe was concentrated in northern Italy. Monitoring such flooding rains with satellites is useful for officials who must assess risk, map damage, and plan for recovery.



### F. Cracking Icy Secrets of New Penguin Colonies

By studying sea ice from space, scientists were able to see cracks in the ice cover where penguins hunt for fish. This information helps them better understand penguin habitats and where they might live and thrive

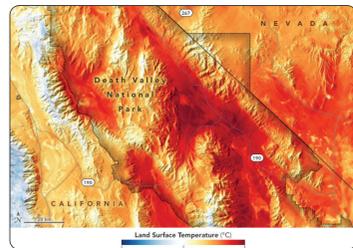
at different times of year. In this map, lines indicate where ICESat-2 detected leads in the sea ice around the Antarctic Peninsula from October 2019 through April 2020. Each point on the lines represents a spot where the satellite detected open water.



### J. Air Pollution on the Move in India

In recent decades, northern India has coped with increasing air pollution from desert dust and from airborne particles created by the burning of wood, farm stubble, and fossil fuels. New research suggests that

winds are spreading this smoky problem, moving pollution southward in ever-increasing amounts. This map, based on a computer model known as MERRA-2, shows how the amount of black carbon in the air changed each November from 2005 to 2016. Blue areas indicate where concentrations decreased, while orange and red show increases. Poor air quality can harm human health, so scientists use satellites to identify air pollution hot spots.



### B. Mapping Extreme Heat Around Death Valley

In August 2020, temperatures in the desert of Southern California approached the highest levels ever recorded on Earth. NASA's ECOSTRESS instrument on the space station observed land surface

temperatures during the heat wave. Extreme heat can have serious impacts on resources like water and energy, and sometimes on human health. Knowing where and when heat waves occur helps scientists better understand climate change.



### The Blue Marble (background image)

In 2002 and 2005, NASA produced the Blue Marble, the most detailed true-color image of our planet ever produced. Using data from NASA's Terra satellite, scientists and data visualizers stitched together four months of observations of the land surface, oceans, sea ice, and clouds into a photo-like mosaic of every square kilometer of our planet.